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# Use of the domination property for interval valued digital signal processing

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# WHAT IS LINEAR FILTERING ?



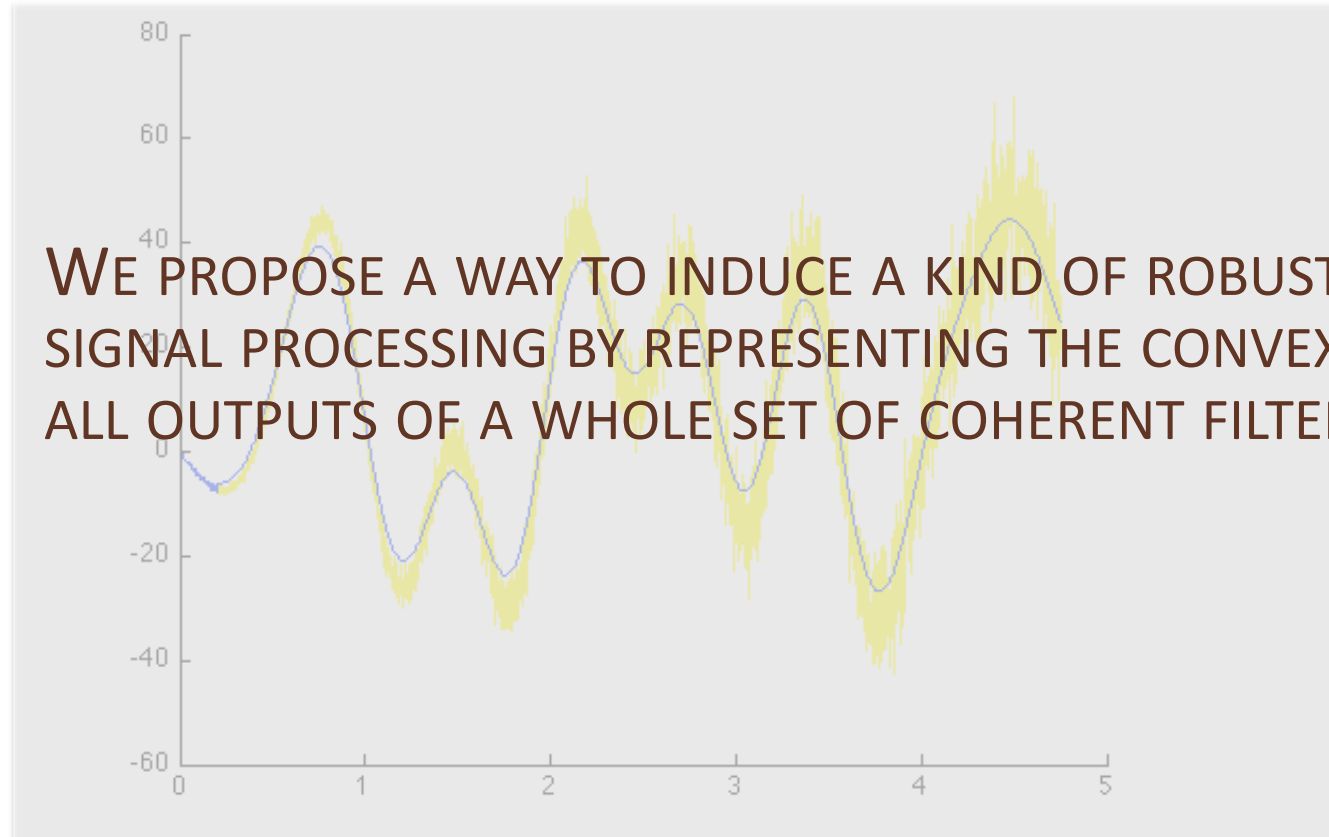
$$y_n(t) = \sum_k (x_k \star k_{n-k})(t)$$

$k$  is the impulse response of the filter

$$k \text{ summative kernel : } \sum_n k_n = 1$$



**FIND THE IMPULSE RESPONSE ... CAN HAVE A DRASTIC INFLUENCE ON THE PROCESSED SIGNAL ...**



**WE PROPOSE A WAY TO INDUCE A KIND OF ROBUSTNESS IN SIGNAL PROCESSING BY REPRESENTING THE CONVEX HULL OF ALL OUTPUTS OF A WHOLE SET OF COHERENT FILTERS.**

**... AND SOMETIMES IT CAN BE DIFFICULT TO SPECIFY THE RIGHT IMPULSE RESPONSE !**

## DIFFERENT WAYS TO EXPRESS CONVOLUTION

- $y_n = \sum_k x_k \kappa_{n-k}$

- $y_n = \sum_k x_k \kappa_k^n$

- $y_n = E_{P_{\kappa^n}}\{x\}$

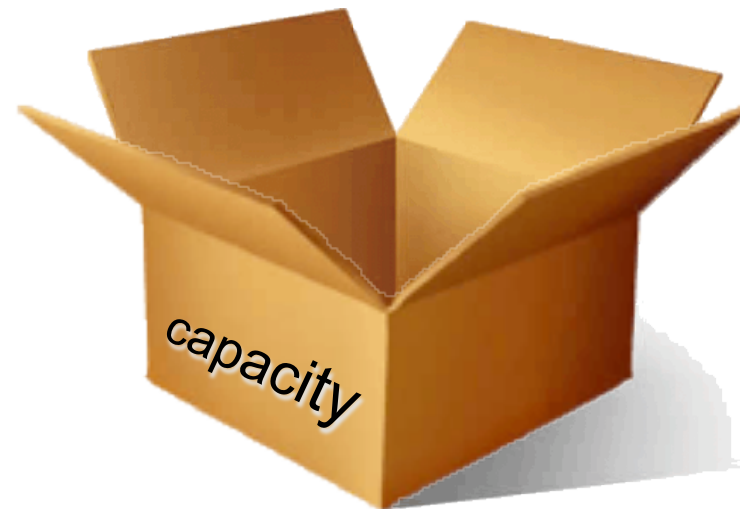
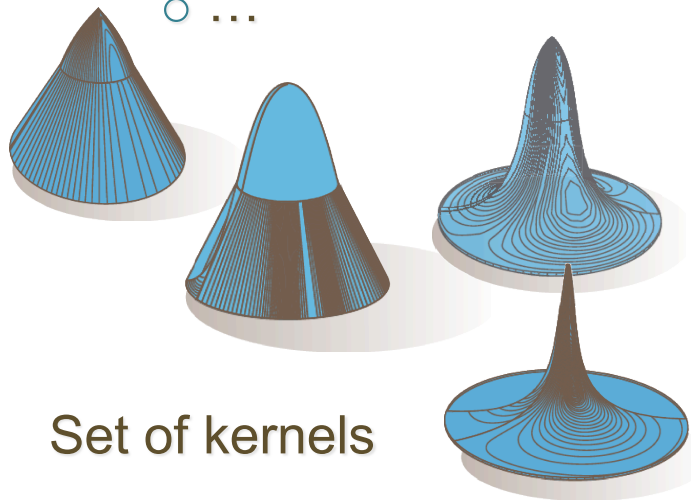
$\kappa^n$  is the kernel  $\kappa$  translated in  $n$

$P_{\kappa^n}$  is the probability of being in the neighborhood of  $n$  (via  $\kappa$ )

... thus a set of kernel is equivalent to a set of probability ...  
i.e. a credal set.

## PRACTICAL REPRESENTATION

- possibility distribution (maxitive kernels)
- clouds (cloudy kernels)
- pi boxes
- ...



$$M(v) = \{ P \text{ (probability)} / A \subseteq \Omega, P(A) \leq v(A) \}$$

## HANDLING EPISTEMIC UNCERTAINTY

- Partial knowledge due the need of an expert to identify a model (Loquin and Dubois)
- Partial knowledge due to poor information on the state of the considered system (Laâmari et al.),
- Partial knowledge due to inherent vagueness of the natural language (Lawry),

HOW TO REPRESENT WHAT HAPPEN TO A RANDOM VARIABLE WHEN IT GOES THROUGH AN ILL-KNOWN SYSTEM?

## DISCUSSION DO NOT FORGOT YOUR ATTENTION!

- How to combine in a single model epistemic uncertainty and random variations (due to observation)?
- How to keep low-computational complexity?
- How to provide results that can be easily interpretable?
- How to access to information of this partial knowledge?
- How to compare the new methods we propose to more traditional methods (especially when comparing bipolar to unipolar or interval-valued to single valued)?